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THE RELATIVE EFFECTIVENESS OF STRESSFUL AND REWARDING CHARACTERISTICS OF PRIMARY AND SOCIAL REINFORCERS IN THE CONTROL OF CANINE BEHAVIOR

Principal Investigator

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FINAL REPORT

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CANINE BEHAVIOR LABORATORY

UNIVERSITY OF MARYLAND

College Park, Maryland

Acknowledgements

The systematic collection of reliable data such as is reviewed in this report requires personnel dedicated to consistency and reliability in such a way as to be unique persons in this culture. Persons with these qualities connected with our staff were: Mrs. Melba Aldridge, Mr. Hank Davis, Mrs. Eileen Franch and Mr. Dale Reeves. Without the dedication of these individuals, the quality of the research accomplished would be much reduced.

A special expression of gratitude is also due to Col. Wm. Peacock and Col. John Powell for their advice and medical assistance in the carrying out of the project.

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PART I

INTRODUCTION

The report summarizing the work accomplished on this project by May of 1966 summarized research comparing traditional laboratory consequences (food, shock, etc.) with those kinds of consequences more frequent in the natural environment of the dog and in the training of the dog as the Army carries out that training (praise, petting, verbal commands, reprimands, etc.). The objectives stated in the proposal concerning the work accomplished in this last year of the project ending August, 1967 were to focus "...on the optimum trainability of the dog using social consequences".

Three questions were stated under the "Specific Aims" section of that proposal. One dealing with the ability of these social controls to maintain long chains of behavior in the dog, a second dealing with the possible effects of early experience on the efficiency of these social controls, and a third dealing with a possible opportunity to do selective breeding in order that sensitivity of the dogs to social control might be improved.

To carry out the methods described in that proposal two training and evaluative procedures have been developed in the laboratory. One of these is extensively described in the annual report dated May, 1966. This procedure involves an objective measurement of the performance of a dog to discipline commands given in the open field. The consequence for this behavior is social praise. The other evaluative procedure which has been used in the present research is a maze through which the dog must work in order to receive his daily ration of food. In both of these procedures the chain of behavior has been expanded throughout training in order to access the ability of the dog to work for long periods of time without reward (the first question stated above). These procedures have also been used to provide early experiences to parts of litters born in the laboratory in order to access the contribution of early experience training to later adult performance (the second question stated above). The adult performance has been used to guide the selection of dogs for mating for future generations born in the laboratory (the third question stated above). All of these procedures have been subsummed under one general training schedule carried out during the past year and described in the following section.

PART II

TRAINING AND EVALUATIVE PROCEDURE OF CANINE BEHAVIOR

MAZE PERFORMANCE

Figure 1 illustrates the procedure followed in the use of the maze training area in which the individual being evaluated obtains his daily ration of food. The animal works his way through a series of gates, fences, and passageways by pushing up wooden doors which are hinged on their top edge. During the first five sessions in which the animal is trained in this apparatus the doors are left locked and unlocked in such a pattern as to face the animal with a three choice decision immediately after starting the problem. Two of these choices are obstructed by locked doors, the third choice allows direct access to the reward area. Some particles of food are left in the runway just beyond this correct door. The apparatus locking the two incorrect doors is so arranged as to allow an indication on the electrical recording equipment of each time that the dog attempts to push one of these doors.

In addition to the measurement of errors, a measurement of time spent solving the problem is also recorded. As the dog crosses the threshold of the first gate (see the upper right hand photo of Figure 1) the handler operates a switch which allows the electronic equipment inside the laboratory to begin counting seconds. This count is stopped when the dog pushes through the correct door. As the daily trials continue, the complexity and number of choice points in the maze problem is expanded, and both errors and latencies are recorded at each choice point. This means that every time the dog pushes through another correct door, a time is recorded and a new timer begins counting. The time at each choice point, errors at each choice point, total errors and total time are recorded for each dog on each day that he works through the maze.

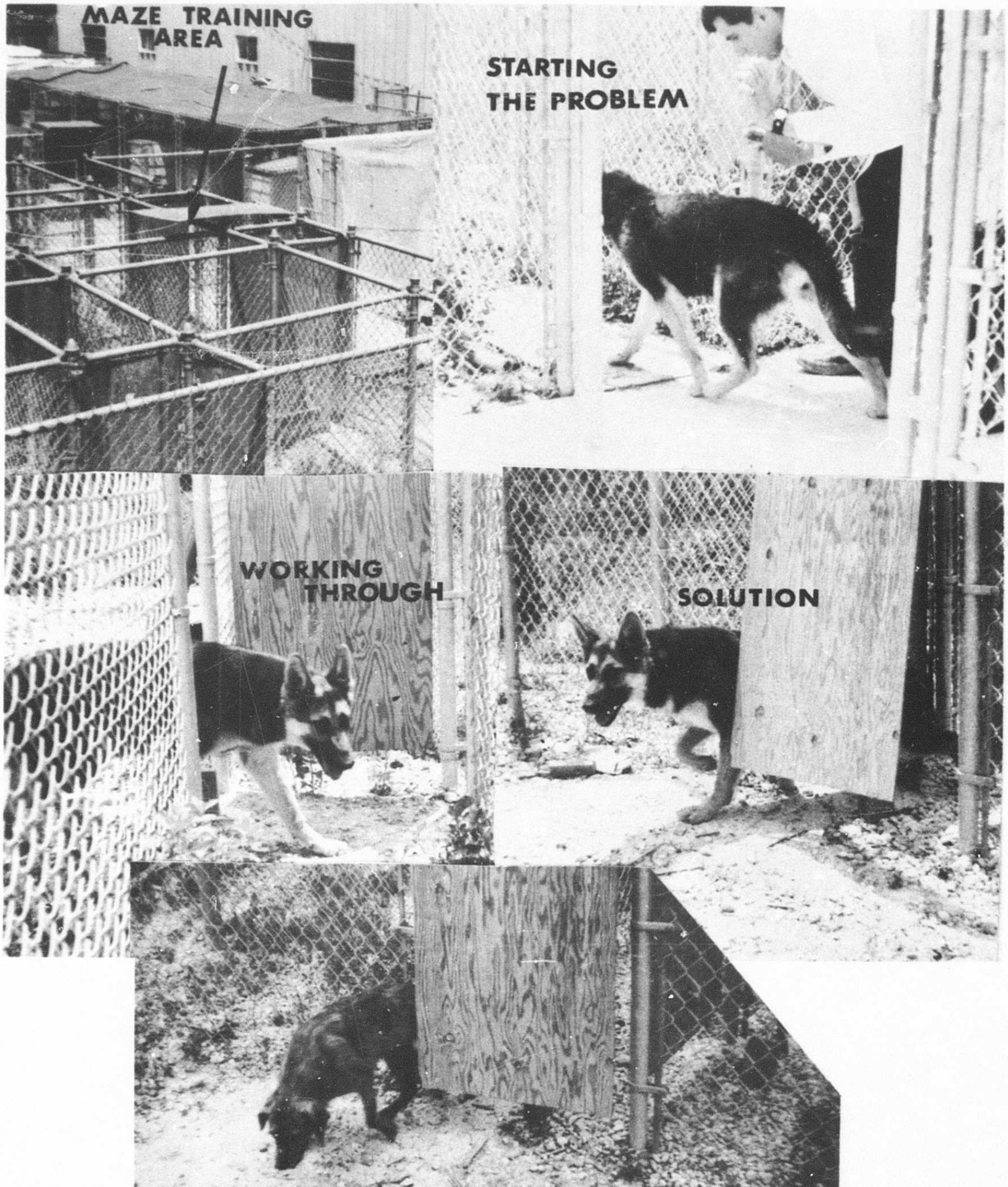

FIGURE 1. MAZE PROBLEM SOLVING EVALUATION.

As can be seen in Figure 1 the maze is basically a construction of hallways around small 5' by 5' areas enclosed by chainlink fence. These hallways are 2' wide allowing for doors about 22" wide. The overall height of the fencing making up the area is 5'. The switch sensitive to the opening of correct doors is merely a standard wall-type mercury switch bolted to the door at such an angle as to allow activation when the door is tipped. Errors are recorded by switches mounted close to the wooden bolts which are holding the doors closed.

DISCIPLINE TRAINING EVALUATION

In this situation the 1/2 hour session was carried out by E presenting each of five commands (sit, come, down, stay, heel). Action of a switch by E activated a counter inside the laboratory which counted seconds. The second action of this switch stopped this counter and, therefore, allowed formation of latency, that is the time between E's command and S's performance. A second switch available to E allowed selection of a different counter for each command. Thus a measure over a half hour period was made of the latencies of each of the five commands. At the outset, E forced S to the position indicated by the command and pulled his leash in cases of come and stay. After the response had been performed or forced by E, the dog was praised verbally and petted about the ears and head by E if he were directed to do so by the automatic equipment.

Figure 2 shows the forcing procedure in the photo at the top of the page. Note that there is a small panel of lights in the discipline training area which allows E to note which command has been selected by the automatic equipment and whether or not a latency is being timed. Also, this panel of lights indicates to the handler when the proper number of commands have been given for that dog for that day. Some switches are available on this panel in order that the handler may switch to a new set of counters for a new dog without having to go back inside. The forcing of the posture indicated by the command is performed by the handler only if the dog fails to respond spontaneously within the first 15 seconds.

As Figure 2 shows this forcing may take a more and more subtle form in later training as in the case of the photograph marked "Stay". In

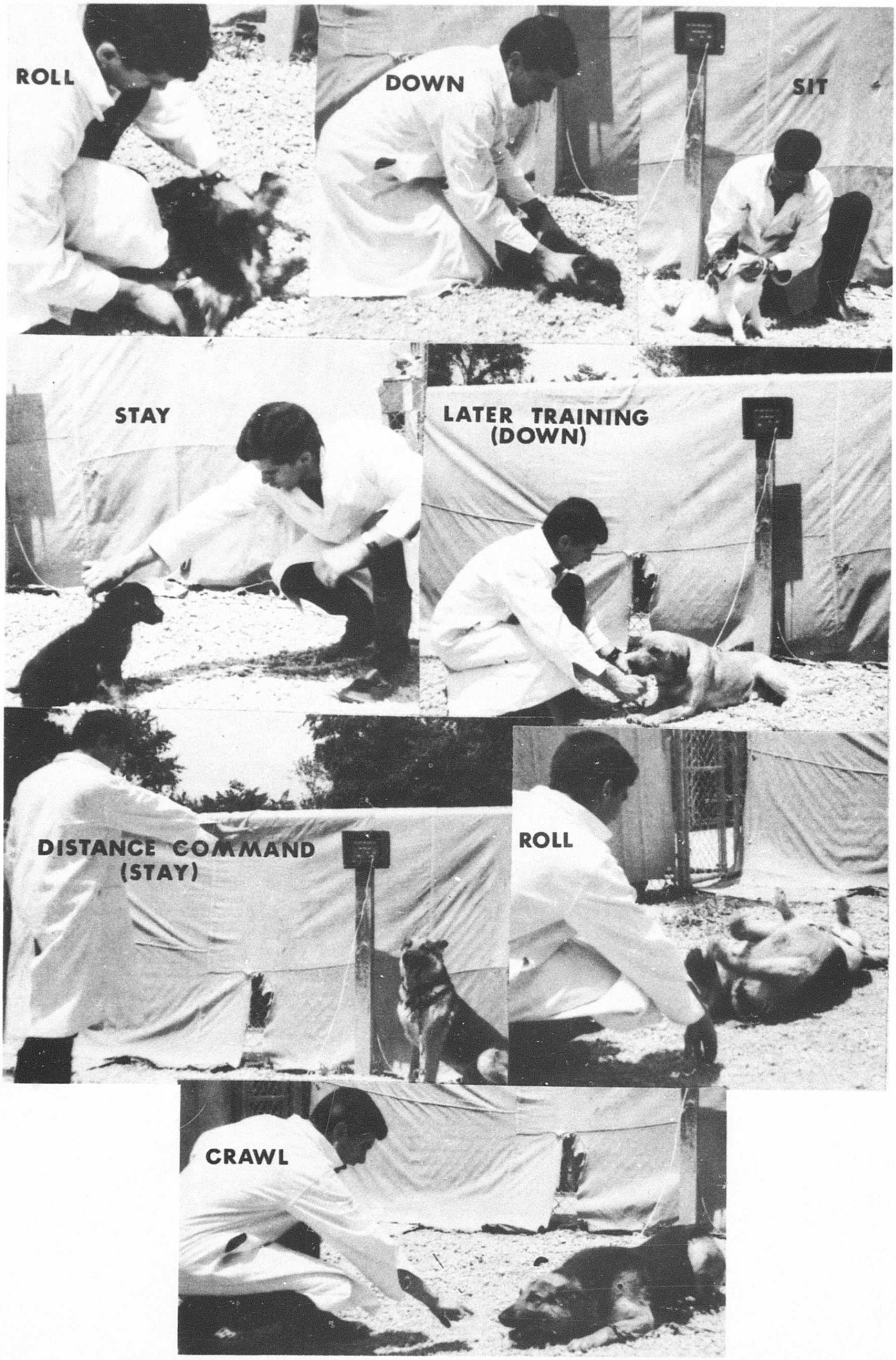

FIGURE 2. DISCIPLINE TRAINING EVALUATION BEGINS EARLY.

the next 18 day phase, the frequency of reinforcement is reduced so that instead of petting and praising occurring after every correct performance, petting and praising occur only after every 6th performance on the average. At the end of another 18 days this frequency is reduced so that petting and praising occur only after every 11th performance on the average. From this procedure, an average response latency for discipline performance is obtained and used as a criterion for selection and breeding.

Figure 3 illustrates the discipline performance of some first generation dogs. Training sessions 1 through 9 of this figure were carried out under conditions where petting reinforcment occurred on the average of every eleventh command (VR-11). Training sessions 10, 11 and 12 represent data collected under conditions of VR-16. The notes at the extreme right hand part of the figure indicate the action taken for selection and breeding of these animals. Bullah, the worst performing dog (highest response latencies), was bred to an unevaluated pure bred Collie before she was received in the laboratory. Nellie was a cross between a German Shepard and a Terrier and was bred to a Labrador Retriever who had received extensive training in our personnel reconnaissance program. This Retriever was not evaluated in these data due to his extensive specialized training. Of the three best performing dogs in Fig. 3, Slugger was the only animal who had received experience in training and performance of scout dog duties for the K-9 Corps in the Army. He was bred to a full-blooded German Shepard who was not the property of the laboratory.

Figure 4 represents in the extreme left-hand section the maze performance of these particular dogs; however, the reader will note

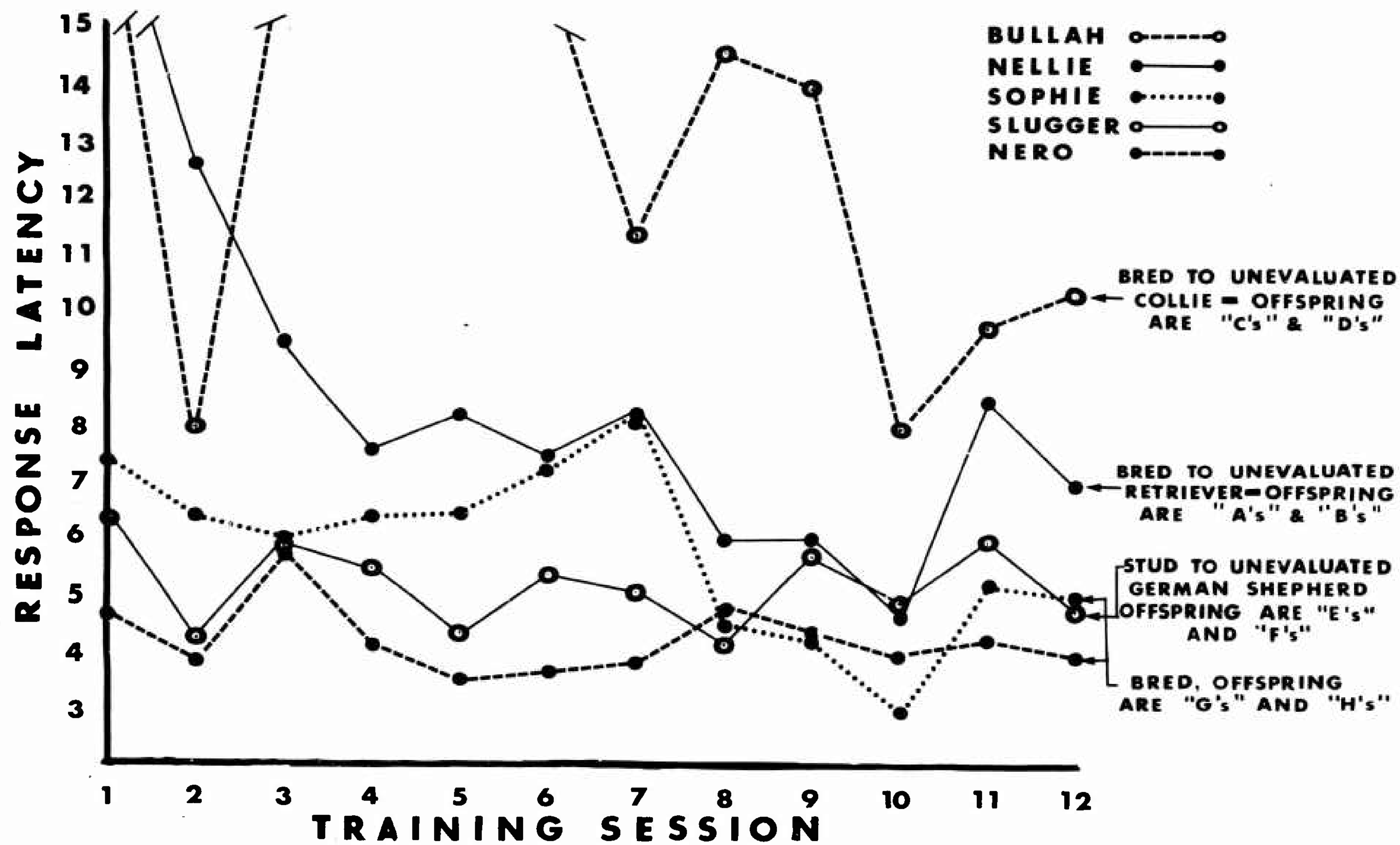

FIG. 3 DISCIPLINE PERFORMANCE AND SELECTION OF THE FIRST GENERATION

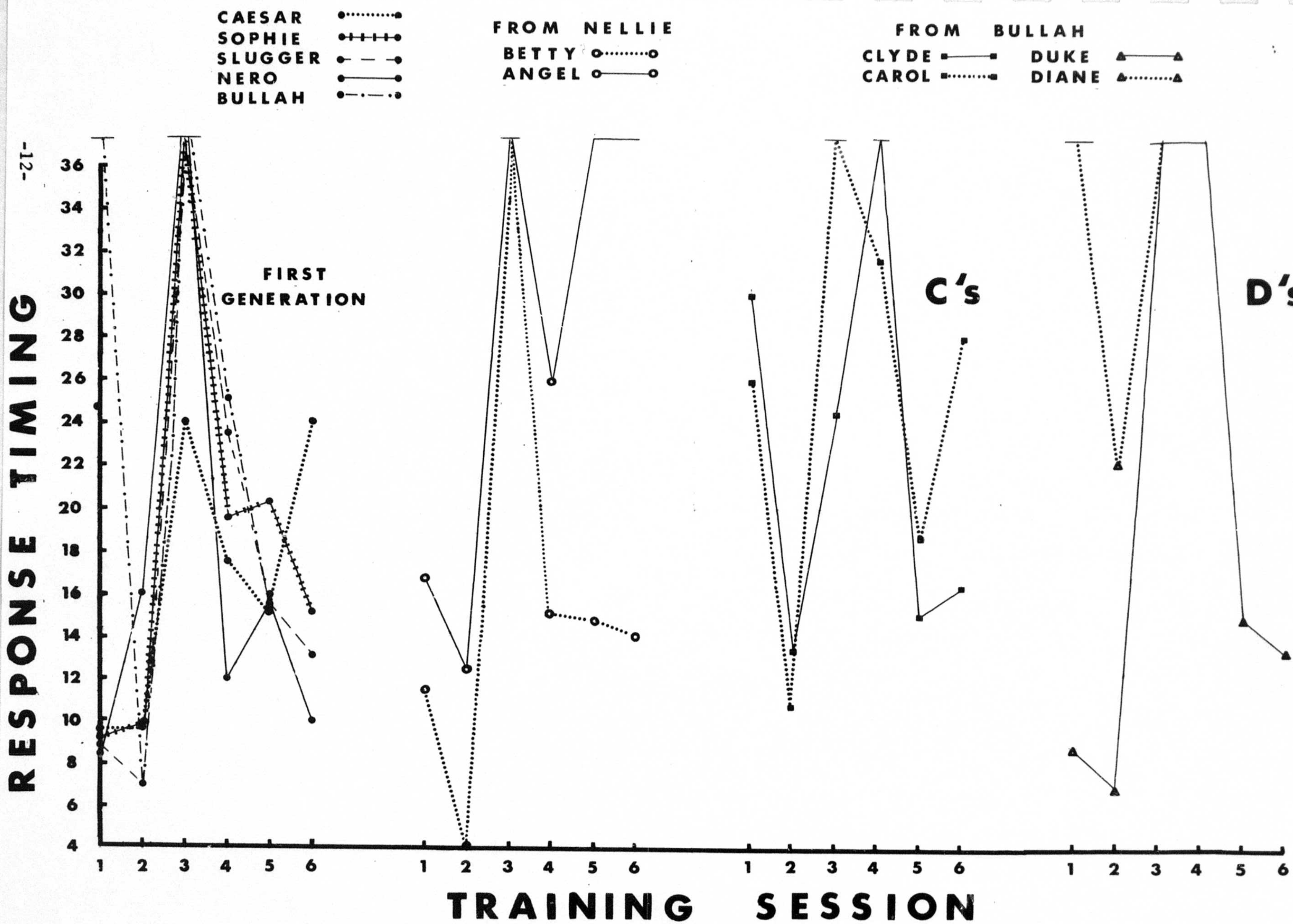

FIG. 4 MAZE PERFORMANCE AND SELECTION OF FIRST AND SECOND GENERATION GERMAN SHEPERDS

that Nellie's performance is not represented in these data. Nellie became frightened and unresponsive in the maze situation and after three days refused to move once placed inside the maze. The reader will also notice the addition of a pure bred German Shepard, Caesar, who performed poorly in the maze situation and was not bred in the program

PERFORMANCE OF THE MONGRELS IN THE SECOND GENERATION

Some second generation mongrels performed very poorly in the maze task. Of Nellie's seven puppies only Betty and Angel performed the maze well enough to be evaluated. Of Buelah's seven puppies only the four represented in the right hand graph of Fig. 4 performed well enough to be evaluated. Even here one dog, Dianne, performed below 36 seconds only once in the last six days of performance.

Figure 5 represents discipline performance data of the five second generation mongrels that were bred to produce third generation animals. The reader will note that average performances are still running below thirteen seconds and that these are approximately in the same range as the first generation animals. Note that the breeding of the second generation animals as indicated by the notes on the right hand side of Fig. 5 was limited to a selection of mates from different litters. Thus, the two worst performing dogs from each of the two litters (Duke from Buelah, and Betty from Nellie) were selected for mating. Of the best performing dogs similar selections were made. Carol, the dog performing at the medium value of about 8 was bred to the unevaluated Labrador Retriever mentioned in the above paragraphs.

Figs. 6 and 7 represent the performance of the full-blooded German Shepards of the second generation. If one attempts to draw some comparisons of Figs. 4 and 5 which represent the mongrels of the second generation with Figs. 6 and 7 which represent the German Shepards of the second generation, one notes that the most striking difference is that all German Shepards perform at least as well or better in maze tasks than their parents, while the mongrels of the second generation either failed to perform or performed poorly on the maze tasks. In

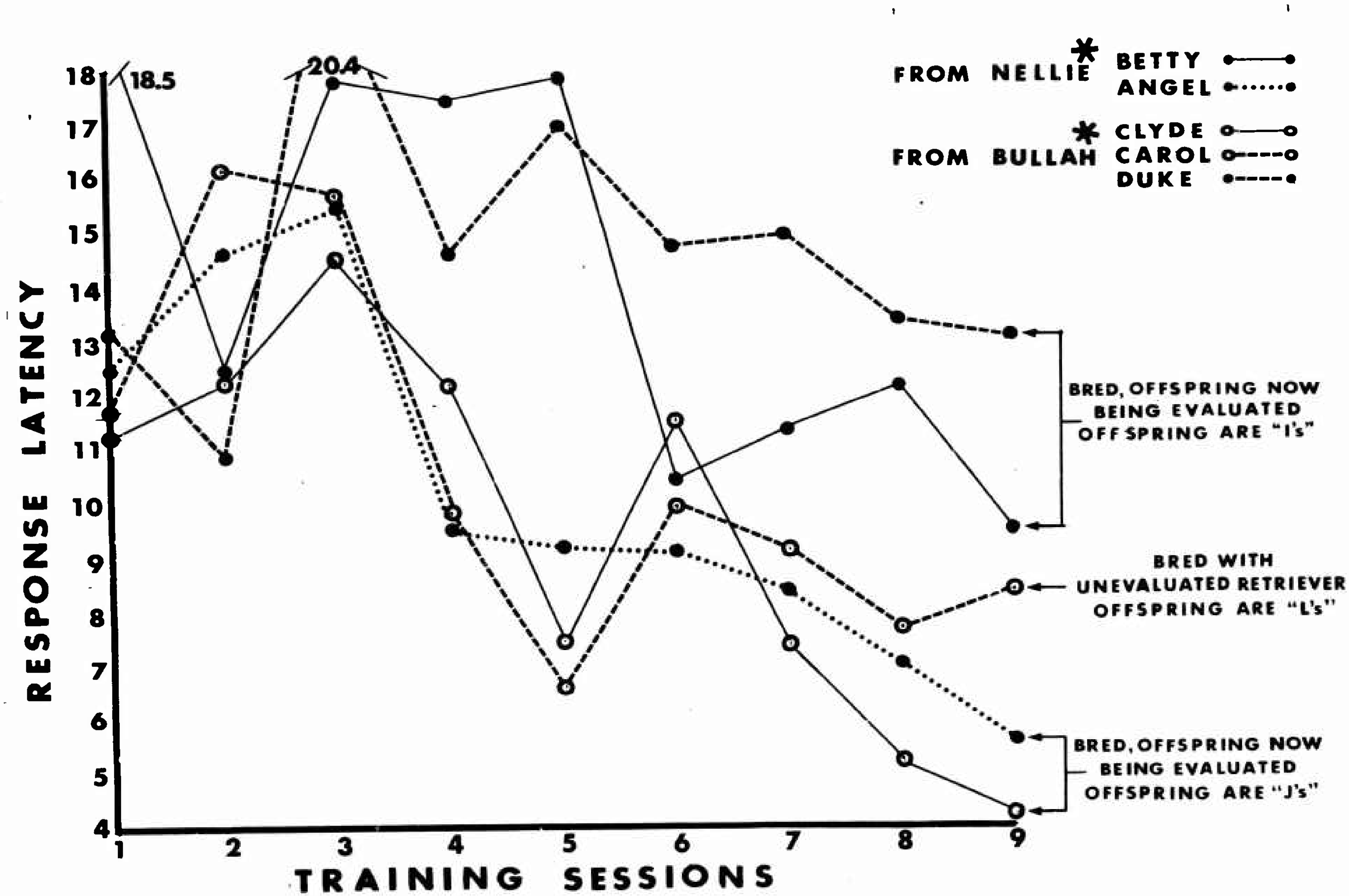

FIG. 5 DISCIPLINE PERFORMANCE AND SELECTION OF SOME SECOND GENERATION DOGS
(*) OTHER MIDDLE RANGE DOGS NOT SHOWN NOR BRED

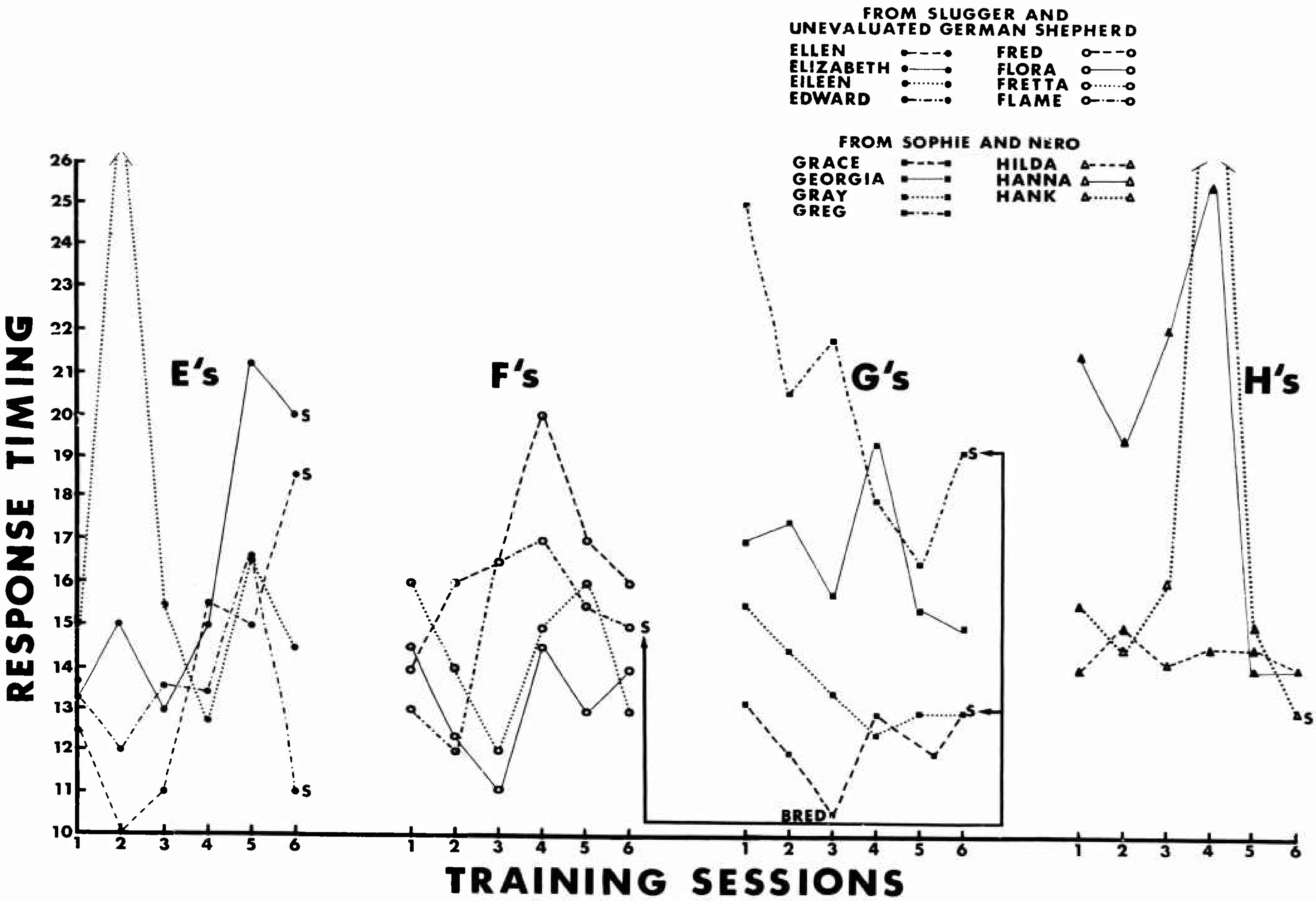

FIG. 6 MAZE PERFORMANCE AND SELECTION OF SECOND GENERATION GERMAN SHEPHERDS
"S" MEANS THE DOG WAS SELECTED FOR BREEDING

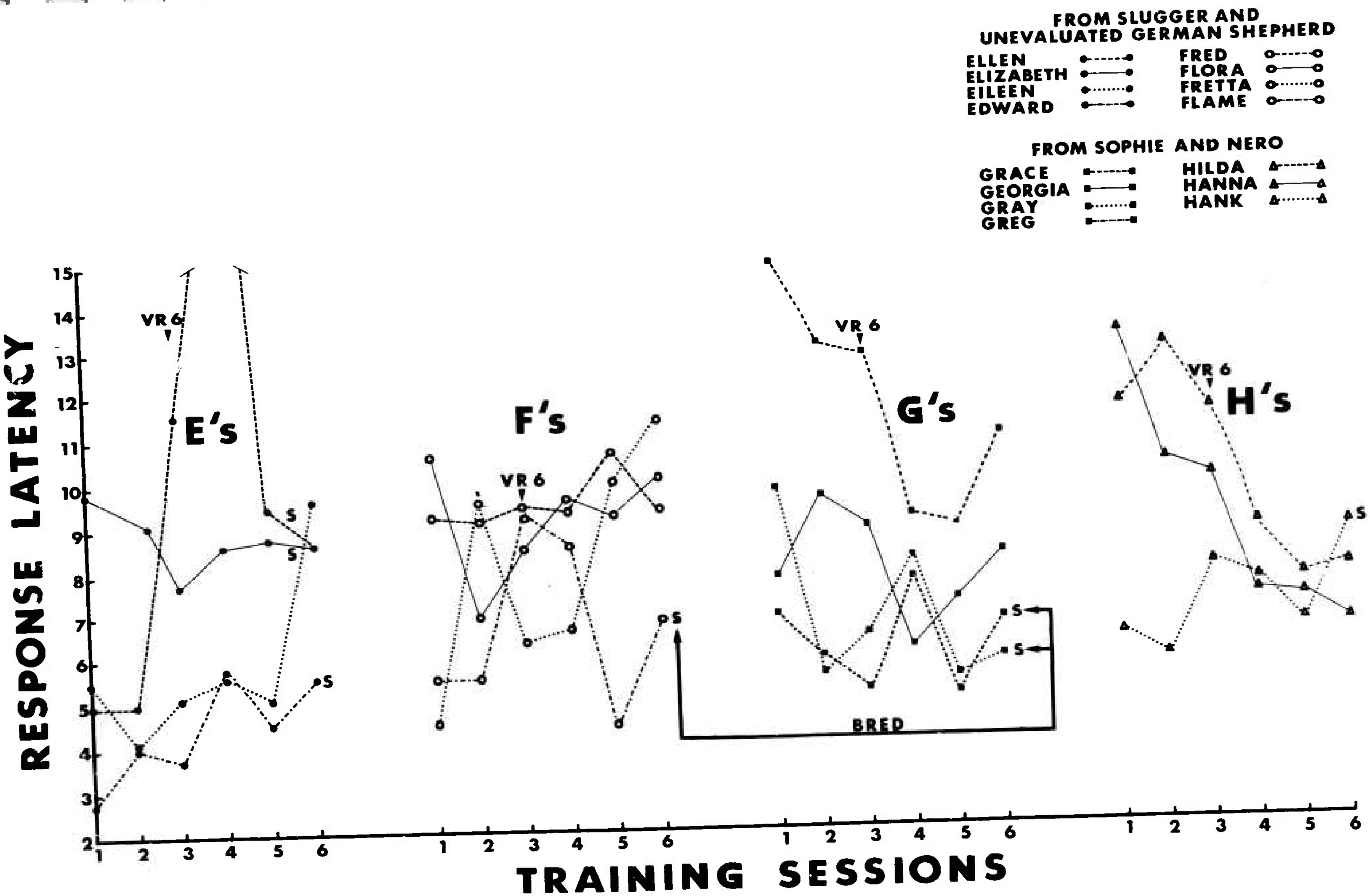

FIG. 7 DISCIPLINE PERFORMANCE AND SELECTION OF SECOND GENERATION GERMAN SHEPHERDS
"S" MEANS THE DOG WAS SELECTED FOR BREEDING

discipline performance these dogs do not seem to differ greatly from the mongrel second generation dogs except for the possible characteristics that very, very poor dogs do not seem to be represented among the German Shepard animals. Selections for breeding among the German Shepard second generation animals is still continuing,but no attempt is being made to select and breed poor performing animals. See Table 1 for a representation of individuals selected for breeding and for early social experience as described below.

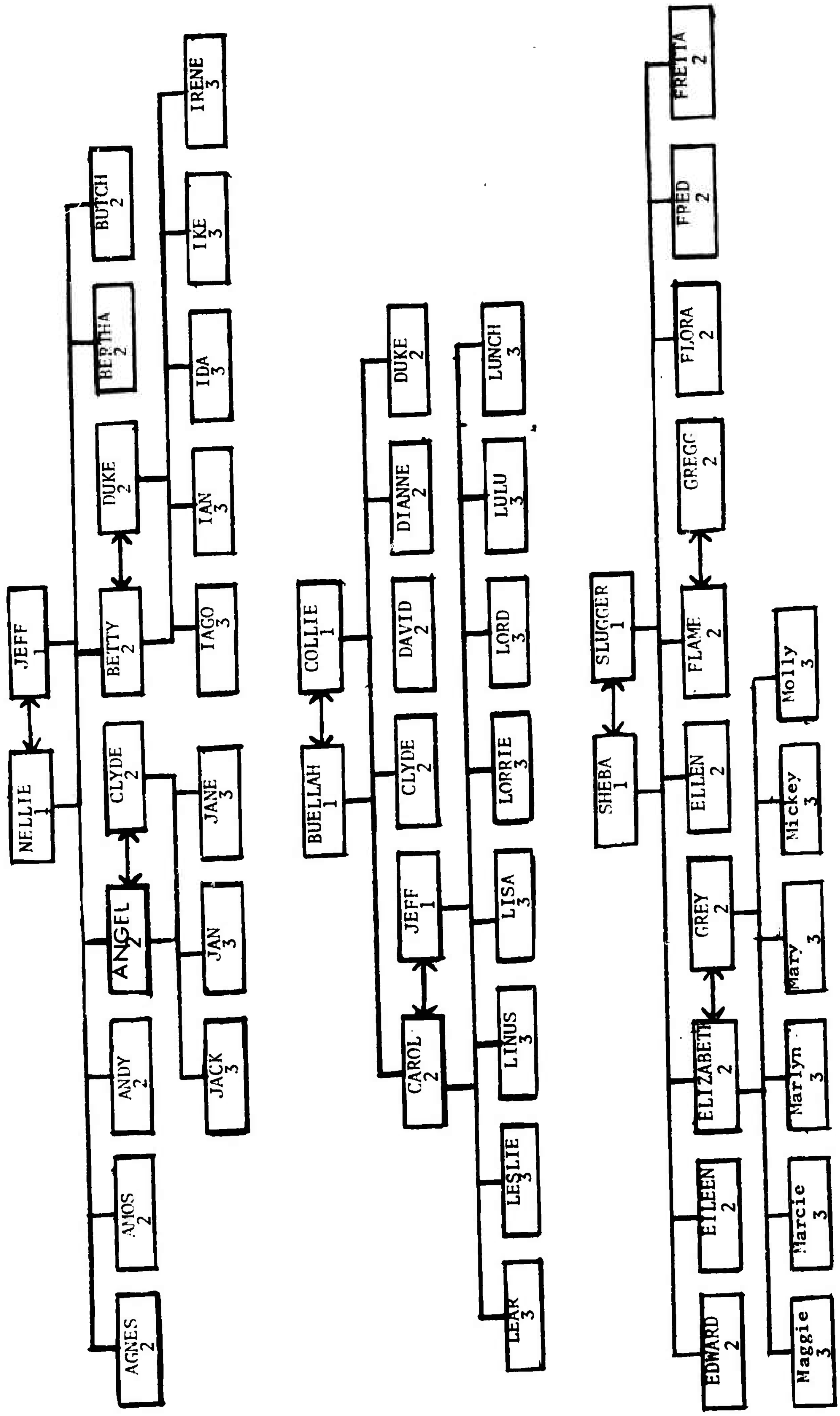
NELLIE 1
JEFF 1
AGNES 2
AMOS 2
ANDY 2
ANGEL 2
CLYDE 2
BETTY 2
DUKE 2
BERTHA 2
BUTCH 2
JACK 3
JAN 3
JANE 3
IAGO 3
IAN 3
IDA 3
IKE 3
IRENE 3
BUELLAH 1
COLLIE 1
CAROL 2
JEFF 1
CLYDE 2
DAVID 2
DIANNE 2
DUKE 2
LEAR 3
LESLIE 3
LINUS 3
LISA 3
LORRIE 3
LORD 3
LULU 3
LUNCH 3
SHEBA 1
SLUGGER 1
EDWARD 2
EILEEN 2
ELIZABETH 2
GREY 2
ELLEN 2
FLAME 2
GREGG 2
FLORA 2
FRED 2
FRETTA 2
Maggie 3
Marcie 3
Marlyn 3
Mary 3
Mickey 3
Molly 3

TABLE 1

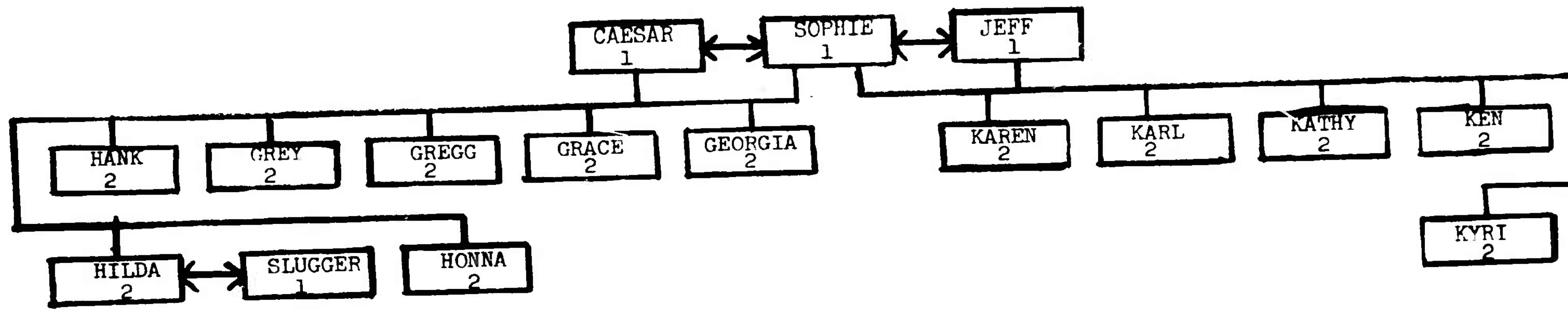

TABLE 1 - (cont'd)

EFFECTS OF EARLY SOCIAL EXPERIENCE

Within any given litter of the second generation, two sub-groups were randomly divided. The first sub-group being given an early letter in the alphabet and receiving early social experience, while the second sub-group of that litter would be given the later letter of the alphabet and would receive no early social experience. This social experience amounted to handling and early training beginning with the fourth week of life as described under earlier sections titled discipline training. Animals not receiving such early experience did not begin discipline training until the fifteenth week. As is most apparent in Figs. 6 and 7, the early experience variable was not effective. The E animals (early experience) generally did not perform better than the F (later trained animals). Similarly, the G's did not perform better than the H's in either the discipline or maze tasks. It should be noted also that in order to gain the levels of performance indicated in these figures, the project was just as successful with animals only four to six weeks old as it was with animals in which training was delayed until the fifteenth week.

Figure 8 illustrates discipline performance of the mongrels, I's, J's, K's and L's. These animals all showed consistent acceptable discipline performance as third generation animals. The K's are not third generation animals, but are the results of a cross between a full-blooded German Shepard (Sophie) and a full-blooded Labrador Retriever (see Table 1). The I's are the result of the selection of the poorest performing mongrels of the second generation and the J's are the result of the selection of the best performing mon-

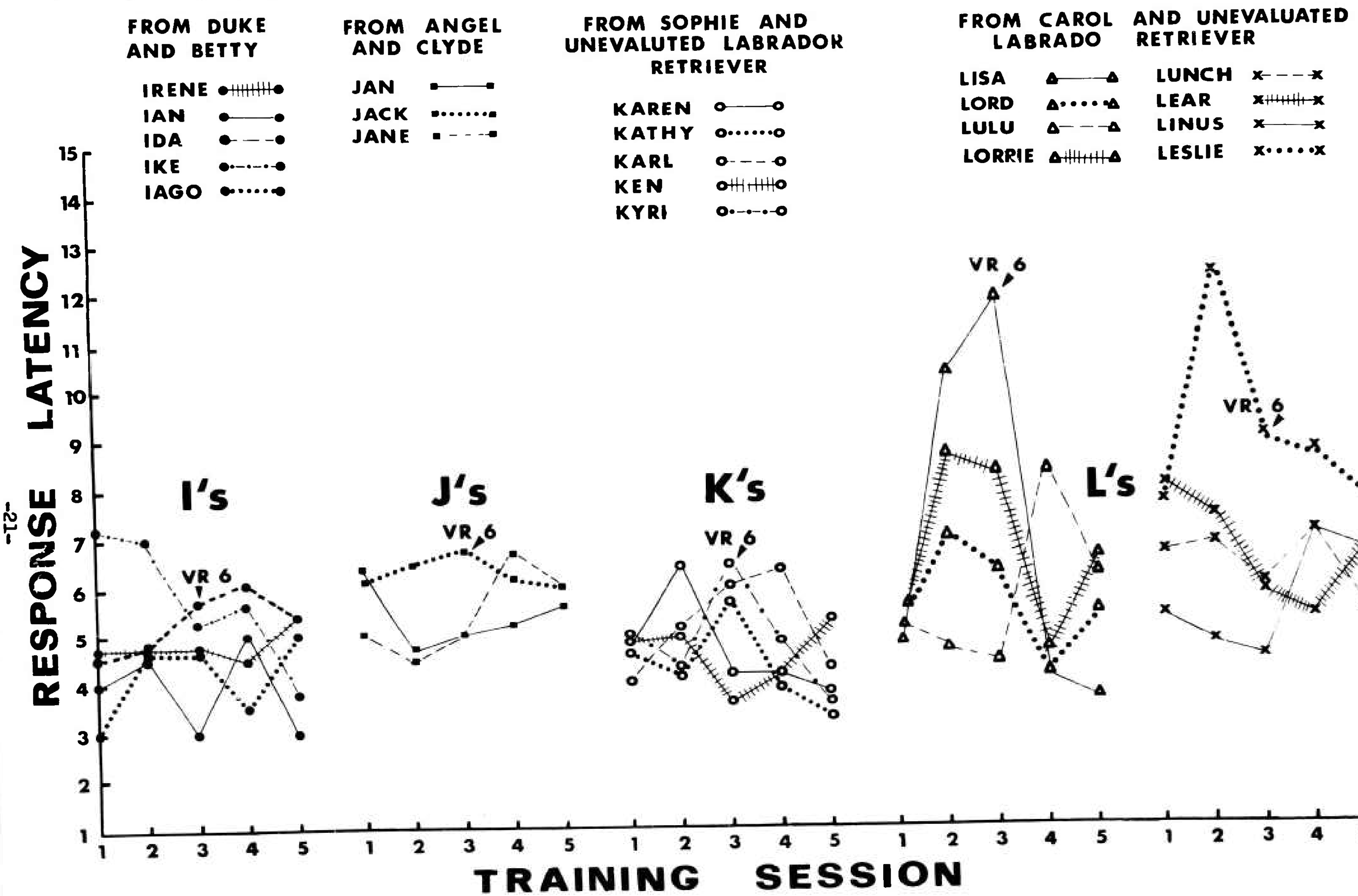

FIG. 8 DISCIPLINE PERFORMANCE AND SELECTION OF THIRD GENERATION MONGRELS

grels of the second generation. The L's were fathered by Jeff, the mother being a high performing second generation mongrel. In summarizing these data, it is accurate to say that the consistency of the performance across animals is remarkably better than in the second generation animal and that their general level of performance is at least as good as some of the best performing second generation animals - German Shepard or not. The result,then,of the second generation selective breeding procedure seems to have been to subtract the presence of poor performing animals among the mongrels. However, generalizations such as these must await the full evaluation of four other German Shepard litters which will be third generation animals and represent the greatest majority of the animals of this generation.

As selection of the third generation animals is carried out to produce the fourth generation, a German Shepard and a mongrel strain will be kept separate and contrasted and evaluated.

PART III

INVESTIGATION OF PUNISHMENT CONSISTENCY AND BEHAVIORAL CONTROL

INTRODUCTION

One of the most crucial characteristics of the training procedure is the frequency of non-contingent punishment. The staff connected with the scout dog program at Fort Benning, Georgia, expressed the phenomenon by stating that if the handler is mean to the dog, it may become "spooked". In our experience at this laboratory, we have found that if the dog is inadvertently and inconsistently yanked by his choke collar or otherwise mistreated in a manner that the dog cannot predict when these punishments are a result of his own behavior, then the general level of performance deteriorates in most respects. Therefore, the laboratory has undertaken investigation of some of the more obvious characteristics that might influence the deterioration of general performance as a result of the predictability of punishment.

Recent literature dealing with aversive stimulation in a variety of experimental situations has indicated that the procedural conditions in which a stimulus is presented may be as critical to the aversive control of behavior as the physical parameters of the aversive stimulus itself. Much experimental data indicate that subjects prefer the presence of stimuli which precede and are reliably associated with shock, to the absence of such stimuli. Lockard (1963) reported that rats preferred an unavoidable shock which was always preceded by a light of 5 second duration to an identical shock with no warning stimulus. Using a T-maze, Knapp, Krause and Perkins (1959) found that rats showed significant preference for the arm of the maze in which unavoidable shock was preceded with a warning stimulus. Perkins, Levis and Seymann (1963) programmed a choice between signal-shock and shock-signal conditions and found that rats preferred the warned delivery of shock (signal-shock). Measuring a galvanic skin response to shock, Lykken (1962) found significant attenuation of this response in rats when the shock was preceded by a warning stimulus.

EXPERIMENT I

The following experiment analyzes the effects of fixed duration (30 sec.) and variable duration ($\overline{X}$ = 30 sec., range = 5-55 sec.) warning stimuli were compared in a conditioned suppression paradigm. In Phase A, the variable duration condition resulted in significantly greater suppression with shock intensity = .8 ma.. In Phase B with shock intensity decreased to .4 ma., no group differences in suppression occurred. In Phase C, the results of Experiment I were replicated and a finer analysis of within CS (warning stimulus) responding made. Significant differences between group suppression ratios were found, as well as clustering of responses within the early part of the warning stimulus by the fixed duration group, as compared to nearly random warning stimulus responding by the variable duration group (see Fig. 9).

The variable duration groups also showed significantly greater resistance to extinction; i.e., the effects of "unpredictable" shock were more difficult to extinguish and deterioration of performance lasted longer. Figure 10 shows the nearly linear increase in responding for the fixed duration group during the series of extinction (no shock) sessions. The variable duration group, however, recovers much more erratically and slowly.

In addition to punishing positively reinforced behavior (such as "praised" or food rewarded behavior in the dog), aversive stimuli can be used to further modify behavior which is primarily maintained by aversive stimuli. I.e., if an animal were responding to avoid shock (rather than to obtain food), this behavior may be further investigated by the delivery of <u>additional</u> shock. As

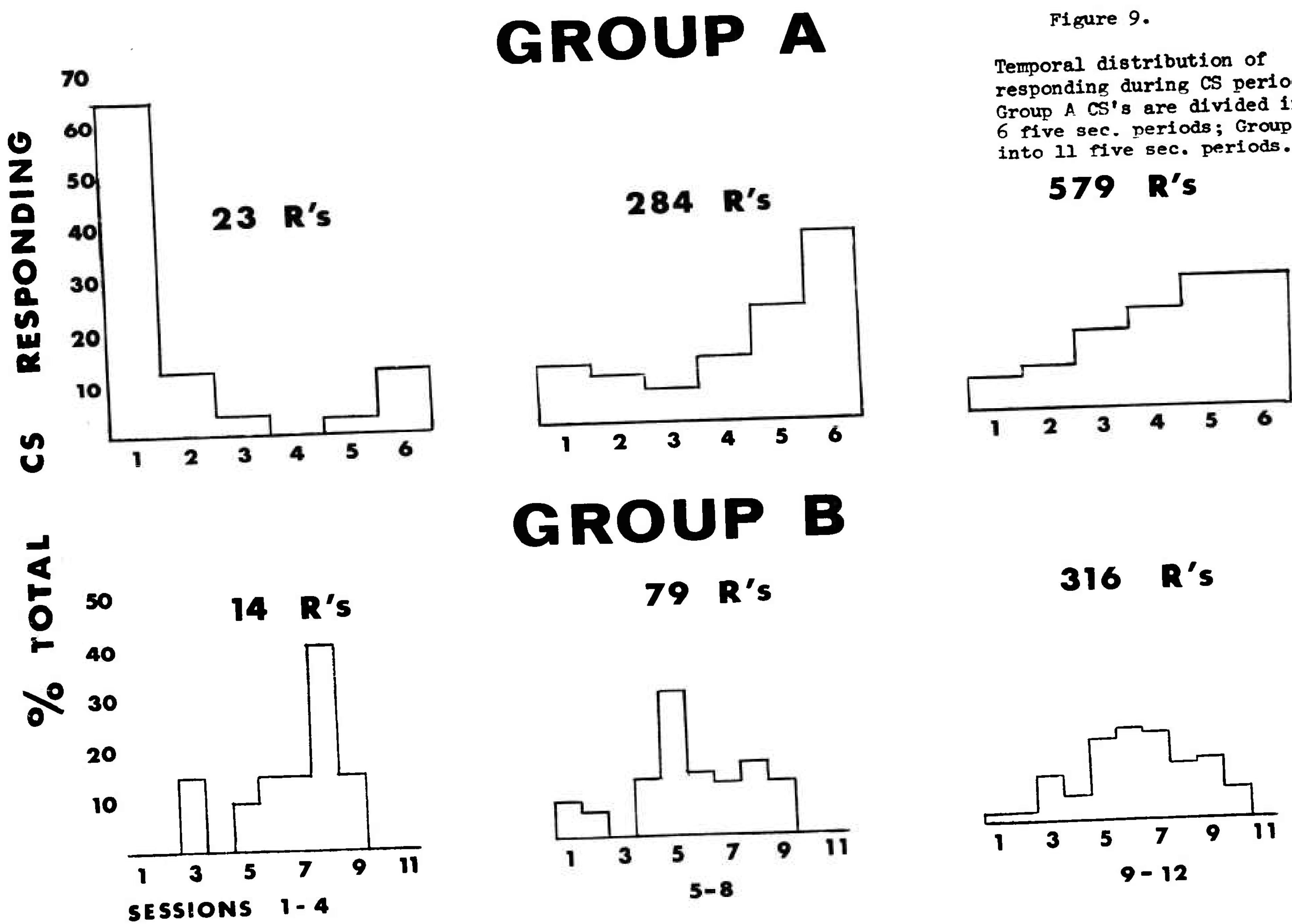

Figure 9.

Temporal distribution of responding during CS periods. Group A CS's are divided into 6 five sec. periods; Group B into 11 five sec. periods.

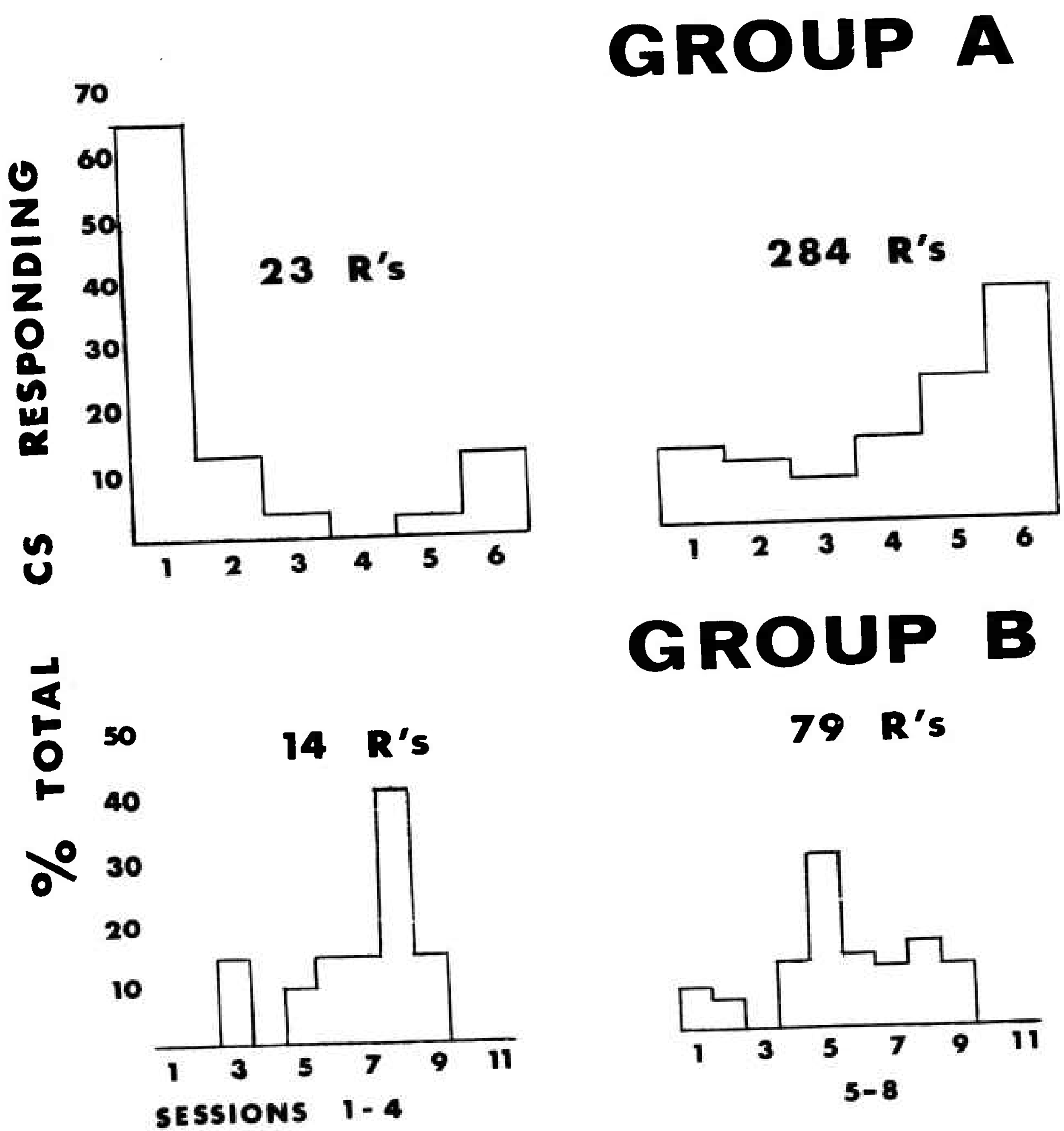

Figure 9.

Temporal distribution of responding during CS periods. Group A CS's are divided into 6 five sec. periods; Group B into 11 five sec. periods.

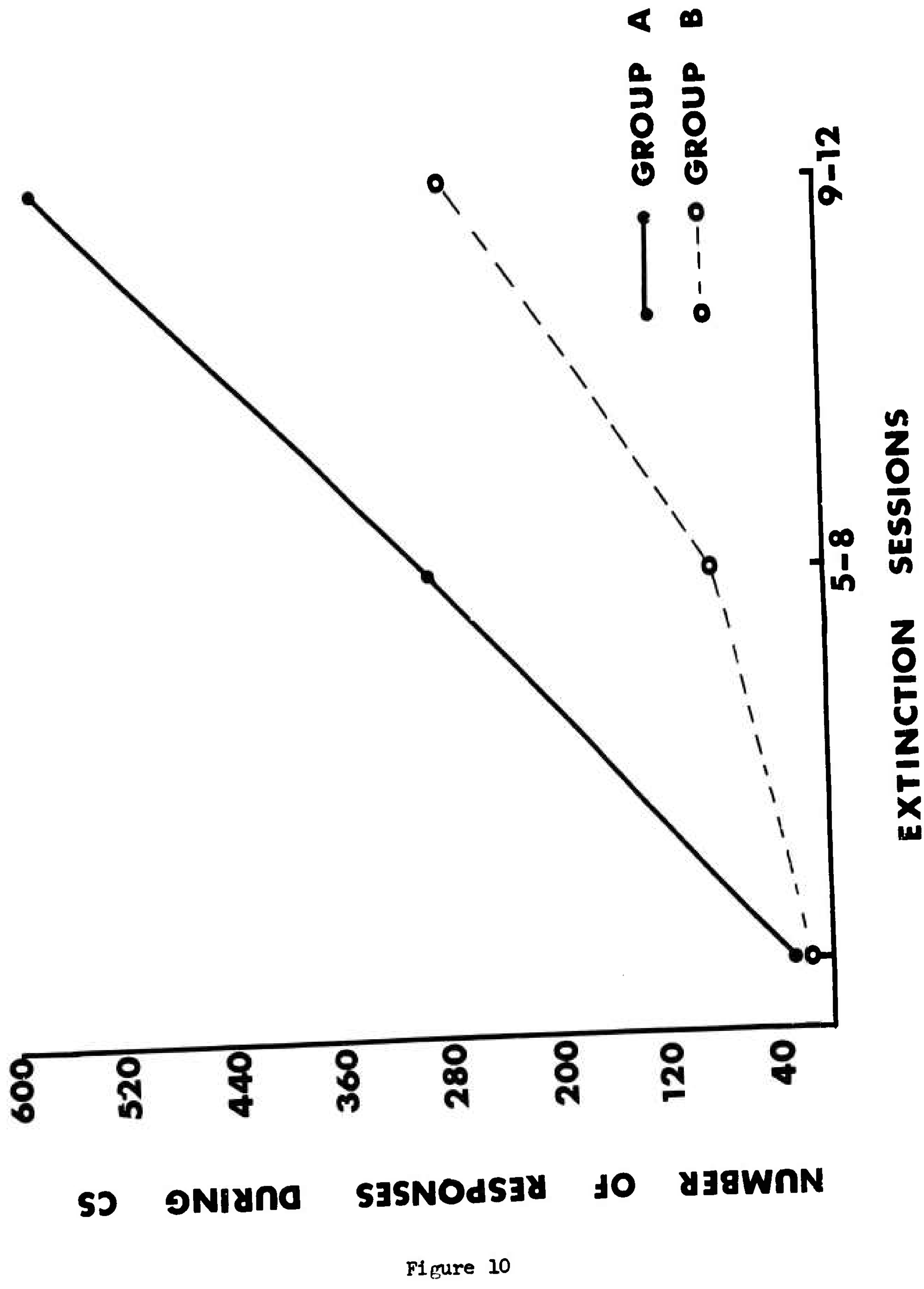
NUMBER OF RESPONSES DURING CS
600
520
440
360
280
200
120
40
EXTINCTION SESSIONS
5-8
9-12
GROUP A
GROUP B

Figure 10

in the previous experiment, this shock may either be under the control of the subject, or of the experimenter. Consistent with the previous research, the results of this shock will be quite different.

EXPERIMENT II

Since the publication of Sidman's initial work with non-discriminated avoidance schedules (Sidman, 1953), relatively few studies have examined the effects of delivering unavoided shock to the avoidance baseline.

Sidman, Herrnstein and Conrad (1957) and later Kelleher, Riddle and Cook (1963) reported an increase in avoidance responding when non-contingent shocks were superimposed on the ongoing avoidance baseline every ten minutes. Both studies reported that the effects of these shocks were so potent that they could maintain avoidance responding even after schedule-delivered shocks had been discontinued, in one case for over 300 experimental hours (Sidman, et al., 1957).

In addition to presenting non-response contingent shocks, recent work by Sandler, Davidson and Holzchuh (1966) has examined the effects of various fixed ratio punishment schedules on an avoidance baseline. During avoidance responding, response contingent shocks equal to 75% of the avoidance shock intensity were delivered at fixed ratios of 12, 6,4 and 2 responses. This punishment procedure produced an initial acceleration of avoidance responding, but in contrast to the free shock work cited above, the response contingent shock rapidly resulted in a marked suppression of avoidance responding. In spite of this reduction in response rate, Sandler et al., (1966) reported that the percentage of shocks avoided did not change.

The following experiment was designed to compare avoidance performance under fixed ratio punishment with a condition in which the same average number of punishments was presented in a non-contingent manner. The same shock parameters were employed in both of the experimental conditions so that any difference in behavior could be attributed to the difference in procedure, rather than to a difference in shock parameters such as intensity or duration.

Four Sprague-Dawley rats were trained to stable performance on a Sidman avoidance schedule (response-shock interval = 15 seconds; shock-shock interval = 5 seconds). Fixed ratio punishment of the avoidance behavior resulted in lower response rates and an increased number of unavoided shocks for all animals. After reestablishing the avoidance baselines, the mean number of previously obtained punishment shocks was presented in a non-contingent manner. This condition resulted in accelerated avoidance rates and a decreased number of unavoided shocks for all animals.

Figure 11 shows typical baseline avoidance behavior (records marked "A"). The records marked "B" represent performance during Fixed Ratio (contingent) punishment, and the "C" records indicate avoidance performance during non-contingent shock.

The pips on the records indicate delivery of unavoided shocks. Note that during non-contingent (unpredictable) shock conditions, responding was accelerated and avoidance is more efficient. When shocks were contingent on avoidance responses, the avoidance behavior deteriorated. These effects are opposite to those obtained in the first experiment in which the behavior in question was maintained by positive, rather than negative reinforcement.

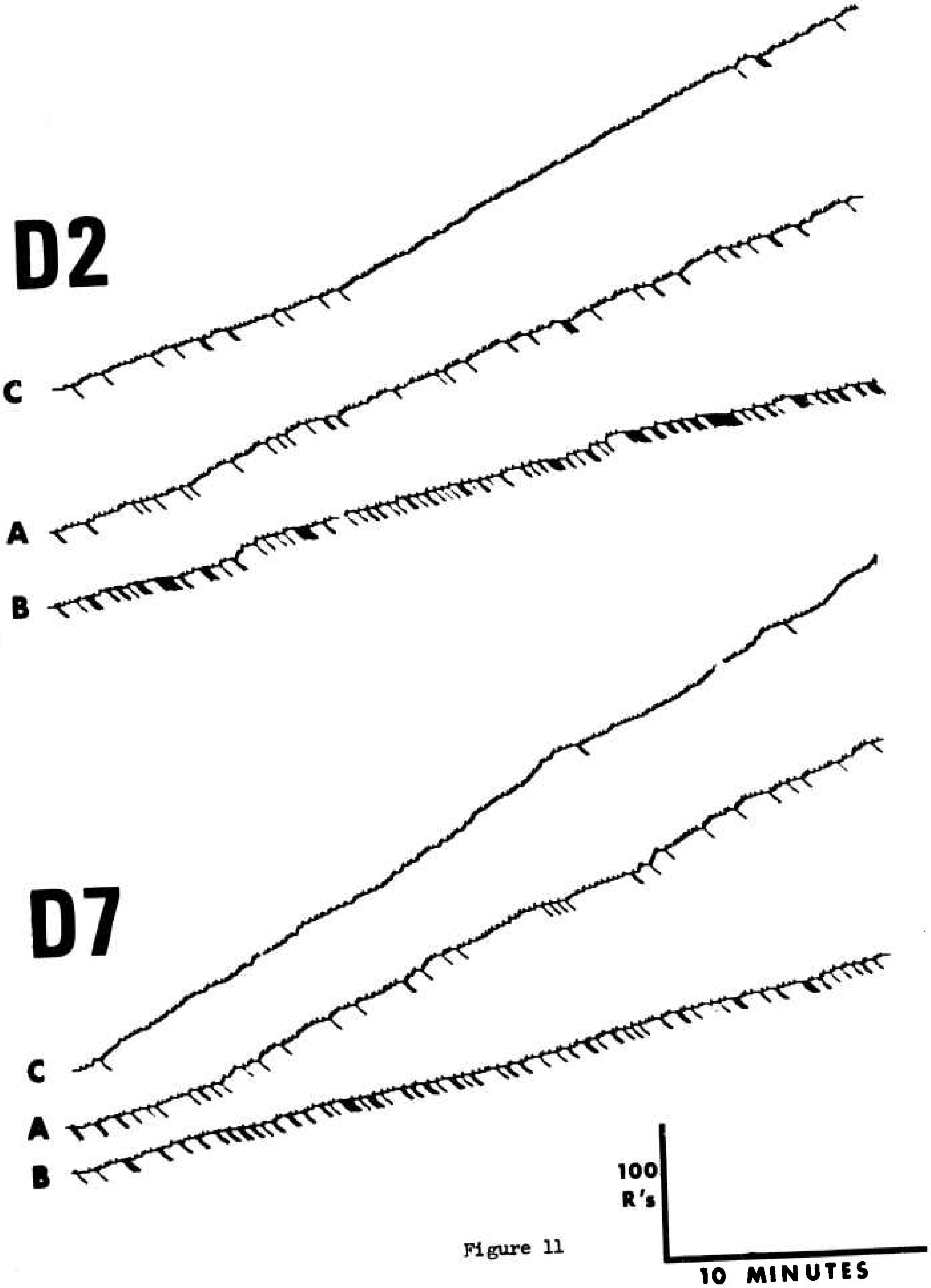

Figure 11

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PART IV

CONCLUSIONS

The three questions quoted from the proposal in the introduction of this report dealt with the maintenance of long chains of behavior, and the possible effects of early experience, and the possible opportunity for selective breeding. The maintenance of long chains of behavior was explored to the extent of maintaining one-half hour's worth of discipline training (30 commands) with the application of only two instances of social reinforcement. On some days during these procedures only one instance of social reinforcement would occur. It seems reasonable to conclude,then, that if there is a limit to the chain of canine behavior which can be maintained by a social reinforcer, it is far longer than those chains explored in the presently reported research.

The early experience variable as explored in these data has shown no significant differences between animals who begin training at the earliest age of weaning and animals whose training begins some weeks or months later. Although this is essentially a negative finding, the data do indicate that there is no necessity to delay training to age one year as has often been the practice inside and outside of Army procedures.

The answer to the selective breeding problem is not entirely clear from the few generations of animals that have been accomplished in this year's work. One somewhat tenuous indication from the data is that careful selection of mates on the basis of behavioral criterion may allow the elimination of the poorest performing dogs. Selection and mating for future generations continues in the laboratory for both the mongrelized and the German Shepard strains. Also, evaluation of other strains which might meet the characteristics demanded by military work are being investigated in the laboratory. These strains include the Labrador Retriever, the standard Poodle and a cross known on the east coast as the Labrador Hound. Such continued observation and selection is the only means to a reliable answer to the selective breeding question

The evidence compiled with regard to the predictability of punishment in such a training program as has been carried out in the laboratory is overwhelmingly consistent in its indication. The extent to which punishment is consistent and predictable is the extent to which that punishment will successfully eliminate or reduce undesirable behavior. The extent to which the punishment is not consistently or reliably related to the animal's behavior or other events in the environment is the extent to which the suppressive and emotional charaacteristics of the punishment will generalize to all activities of the animal. Thus, an unpredictable punishment can be a generalized and emotional disrupter of an entire range of behavior. The report has presented a great deal of evidence collected in this laboratory and has reviewed a great deal of scientific literature, all of which supports these views concerning the predictability of punishment. All of the evidence and activities of this laboratory tend to indicate that the most efficient direction for the animal training program is toward the exploration of the most effective reinforcer in the most effective setting with the least and most predictable punishment that can be engineered for the training procedure.

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Franch, E. O.; McIntire, R. W. and Davis, H. Adaptation to punishment of avoidance responding using concurrent food-avoidance schedules. (in preparation).

McIntire, Roger W. and Davis, H. Sources of resistance to extinction of avoidance performance under concurrent appetitive-aversive schedules. (in preparation).

McIntire, Roger W.; Franch, E.O. and Davis, H. Accelerative and suppressive effects of three levels of unavoidable shock on concurrent appetitive-avoidance schedules. (research in progress).

SUPPLEMENTARY

INFORMATION

DEPARTMENT OF THE ARMY
U.S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
FORT DETRICK, FREDERICK, MD 21702-5012

REPLY TO
ATTENTION OF:

ERRATA
AD-823920L

SGRD-RMI-S (70-1y) 11 DEC 1991

MEMORANDUM FOR Administrator, Defense Technical Information Center, ATTN: DTIC-HDS/William Bush, Cameron Station, Bldg. 5, Alexandria, VA 22304-6145

SUBJECT: Request Change in Distribution Statement

1. The U.S. Army Medical Research and Development Command (USAMRDC), has reexamined the need for the limited distribution statement on final report for Contract No. DA-49-193-MD-2810. Request the limited distribution statement for AD No. 823920L be changed to "Approved for public release; distribution unlimited," and that copies of this report be released to the National Technical Information Service.

2. Point of contact for this request is Ms. Virginia Miller, DSN 343-7325.

Carey O. Leverett
CAREY O. LEVERETT
LTC, MS
Deputy Chief of Staff for
Information Management

151.20/14

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